Schall 03 1990 versus Schall 03 2006: A Comparison of the Calculation Methods for Railway noise with Noise level Measurements

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Introduction

In the planning process for new railway lines or modified railway lines the Schall 03 1990 [1] is the guide line that has to be applied for calculations. Recently this calculation method was updated and revised; the draft of the new calculation method "Schall 03 2006" [2] is now in discussion by the administration. This guide line is structured according to the German and European standards and contains a comprehensive description of acoustic calculation methods for sound emission and sound propagation as well as the calculation of a rating level which shall be used for comparison with the applicable noise limits.

In this paper, a comparison of results of noise measurements, calculation according to Schall 03 1990 and calculation according to Schall 03 2006 will be presented and discussed.

Noise Measurement

The noise measurements were conducted in the area of a railway line with 4 tracks. The measurement point was situated in a distance of 25 m from the next track with a height of 3.5 m above ground level. The speed of trains was measured by radar; the length was determined by counting the number of wagons and multiplying the standard length of wagons. The duration of the measurements was 6 hours, 72 passing trains were measured.

In the following table 1 the number of trains and other acoustic relevant data are listed and compared to the official data to be used in the planning process:

Train type	Measured data		Official data	
	Velocity [km/h]	Length of train [m]	Velocity [km/h]	Length of train [m]
ICE	123	355	140	420
IC	116	300	140	340
IR	118	256	140	205
Express train	104	312	140	340
Regional train	104	130	140	205
Goods train	75	340	90	500

Table 1: Comparison between measured train data and official data

Noise Emission according to Schall 03 1990

The noise emission level according to Schall 03 1990 is calculated using following equation:

$$L_{m,E} = 51 + D_{Fz} + D_D + D_l + D_v + D_{Fb} + D_{Br} + D_{Bü} + D_{Ra}$$

$L_{m,E}$ is the L_{Aeq} in 1 hour of 1 train – pass-by at a distance of 25 m

The value of 51 is the so called "Grundwert" and represents the emission level of a disc – braked train with a length of 100m, at a train speed of 100 km/h with average condition of the rail surface.

In addition to this basic value following parameters are to be considered:

D_{Fz}: effect of type of vehicle
D_D: effect of brakes (disc or cast-iron brakes)
D_l: effect of length of train
D_v: effect of velocity
D_{Fb}: effect of track type
D_{Br}: effect of bridges
$D_{Bü}$: effect of railroad crossings
D_{Ra}: effect of squeal noise

Noise Emission according to Schall 03 2006

The calculation of the noise emission according to Schall 03 2006 is a method using soundpower – levels in octave bands.

$$L_{W'A,f,h,m,Fz} = a_{A,h,m,Fz} + \Delta a_{f,h,m,Fz} + 10\lg \frac{n_Q}{n_{Q,0}}\,\mathrm{dB} + b_{f,h,m} \lg\left(\frac{v_{Fz}}{v_0}\right)\mathrm{dB} + \sum c_{f,h,m} + \sum K$$

$a_{A,h,m,Fz}$ A-weighted overall level of the sound power emitted from the height range h for the source type m of one vehicle unit Fz, equipped with the reference

number $n_{Q,0}$ of sound sources, running at the reference velocity $v_0 = 100$ km/h, on a ballasted track with average condition of the rail surface, neither on a bridge nor on a curved track, in dB,

$\Delta a_{f,h,m,Fz}$ level difference between overall level and octave band level in the octave band f, in dB,

n_Q number of sound sources of a vehicle unit,

$b_{f,h,m}$ velocity factor,

v_{Fz} train velocity, in km/h,

$\Sigma c_{f,h,m}$ level corrections for type of track and rail surface condition, in dB,

ΣK level corrections for bridges and particular nuisance of noise, in dB.

Comparison of noise measurements and calculations

In the following table 1 the differences in the results of noise measurements and noise calculation with the existing Schall 03 1990 resp. the Schall 03 2006 are shown. In this table the parameters for number, length and velocity of trains are the same.

Train type	Emission level L_{mE}			Difference	
	1	2	3	4	5
	measured	Calc. acc. S03 1990	Calc. acc. S03 2006	Column 2 - 1	Column 3 - 1
ICE	52,9	58,5	57,7	+ 5,6	+ 4,8
IC	55,3	59,6	60,1	+ 4,3	+ 4,8
IR	52,8	57,2	57,8	+ 4,4	+ 5,0
Express train	48,4	54,2	53,8	+ 5,8	+ 5,4
Regional train	58,7	61,6	61,8	+ 2,9	+ 3,1
Goods train	60,3	60,3	62,9	0	+ 2,6
Total	64,2	66,9	67,7	+ 2,7	+ 3,5

Table 2: Comparison between measured and calculated emission levels considering the measured train data velocity and train length

The differences between measurement and calculation can be deduced on the condition of the rail surface. Obviously the condition of the rail surface was far above average. It can also be deduced that the calculation method considerably overestimates the measureable noise levels.

Train type	Emission level L_{mE} calculated according to S03 2006		Difference
	1	2	3
	Measured train data	Official train data	Column 2 – 1
ICE	57,7	59,1	+ 1,4
IC	60,1	61,8	+ 1,7
IR	57,8	58,2	+ 0,4
Express train	53,8	56,7	+ 2,9
Regional train	61,8	66,7	+ 4,9
Goods train	62,9	65,6	+ 2,7
Total	67,7	70,7	+ 3,0

Table 3: Comparison between calculated emission levels considering measured and official train data

Discussion

From the results of the noise measurement and the noise calculation according to Schall 03 1990 and Schall 03 2006 following conclusions can be derived:

There is a systematic difference between the official data to be used in the planning process and the real monitored data. In the observed case the speed of trains according to official data is overestimated between 15 and 40 %, the length of trains was in one case underestimated in all other cases also overestimated. Expressed in dB(A), this difference equates to about 3 dB(A).

The difference between noise measurements and noise calculations with the same velocity and the same length of trains, calculated with Schall 03 1990 is in total about 3 dB(A) and calculated with Schall 03 2006 about 3.5 dB(A) in advantage to the calculations.

In total there is a difference between noise measurements for realistic situation and the calculation with data used for velocity and length of trains used in the planning process of about 6.5 dB(A).

In this moment, there are no findings whether the results of these measurements are generally be used.

References

[1] Schall 03 – Richtlinie zur Berechnung der Schallimmissionen von Schienenwegen, Information Akustik 03 der DB, 1990, (Guidelines for the calculation of sound immission near railroad lines)

[2] Schall 03 – Richtlinie zur Berechnung der Schallimmissionen von Eisenbahnen und Straßenbahnen, (Guidelines for the calculation of sound immission near railroad and tram lines), Draft 2006

[3] Moehler et al.: The New German Prediction Model for Railway Noise "Schall 03 2006": An Alternative Method for the Harmonised Calculation Method Proposed in the EU Directive on Environmental Noise; Acta Acustica united with Acustica, vol. 94; pp. 548 - 552