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Working with EN 12354-1 and -2 in Austria

Judith Lang
A-1090 Vienna, Latschkagasse 4, Austria

ABSTRACT

The system of calculating sound insulation between rooms by summing up the transmission paths in separating and flanking elements was used in Austria since 1982 and standardized in 1992. So there was no difficulty to introduce the basics of EN 12354-1 in the Austrian standard B 8115-4 and to refer to details, especially the K_{ij}-values, in ÖNORM EN 12354-1. It was decided to use the simplified model only. Before the introduction in the ÖNORM a comparison of calculated and measured values for the weighted standardized sound level difference in typical Austrian dwellings, was performed and gave reasonable results. In connection with these the programme BASTIAN was tested. A main part of the standard are tables which show combinations of partitions and flanking elements of different types (heavy, heavy + lining, light weight double leaf) and floors and flanking elements of different types to achieve $D_{nT,w} \geq 55$ dB. These are widely used and detailed calculations are not carried out frequently. EN 12354-2 was also introduced in ÖNORM and some calculations were carried out and compared with measurement results. A question to several Austrian building physicists on their use of EN 12354 and proposals for supplements showed the following themes: use only the simplified model, give additional data for K_{ij} of further types of junctions especially for light weight and wooden constructions, more clear data on accuracy, do not neglect secondary transmission paths, add expanded data on spectrum adaptation terms, add formulas for the data which are given only in tables.

1. INTRODUCTION

The system of calculating sound transmission between rooms by summing up the transmission paths in separating and flanking elements based on the sound reduction indices and the type of junctions was used in Austria since 1982 and standardized 1992 in ÖNORM B 8115-4 “Sound insulation and room acoustics in building construction – Measures to fulfil the requirements on sound insulation”. In 2000 ÖNORM EN 12354-1 and -2 were edited with a national foreword, declaring that parts of the ÖNORM B 8115-4 were to be replaced by the relevant parts of the EN. At the same time the preparation of a new edition of B 8115-4 was started and this 2003 edited. It is based on EN 12354 parts 1, 2 and 3 and may be seen as a “handling document” for the EN. The formulas for the calculation of R’ and of $L'_{n,w}$ were transformed to the calculation of $D_{nT,w}$ and of $L'_{nT,w}$ the quantities which are used to define the requirements in Austria. For details, e.g. the values of K_{ij} it was referred to EN 12354; some details on how to define the sound paths in complicated ground plans were added. It was decided to use the simplified model only. This also because not enough data were available for the calculation in third octave bands.

2. TESTING THE USABILITY OF THE EN 12354 FOR AUSTRIAN BUILDINGS

The applicability of the new calculation procedure according to EN 12354-1 for the Austrian types of construction system was proven before its integration into ÖNORM by a comparison of results of measurements of sound insulation in dwellings with the results of the calculation according to EN 12354-1. Results of measurements of the standardized

sound level difference between rooms side by side (26 cases) and rooms one on top of the other (36 cases) in 28 residential buildings carried out in the years 1995-1999 were made available for the comparison. The comparison between the results of the measurement and the calculation for each of the cases is shown in figure 1 and figure 2[1].

Furthermore, measuring results for 17 rooms one on top of the other and 6 rooms side by side were available from an earlier investigation[2]; for these the calculations were also carried out for comparison.

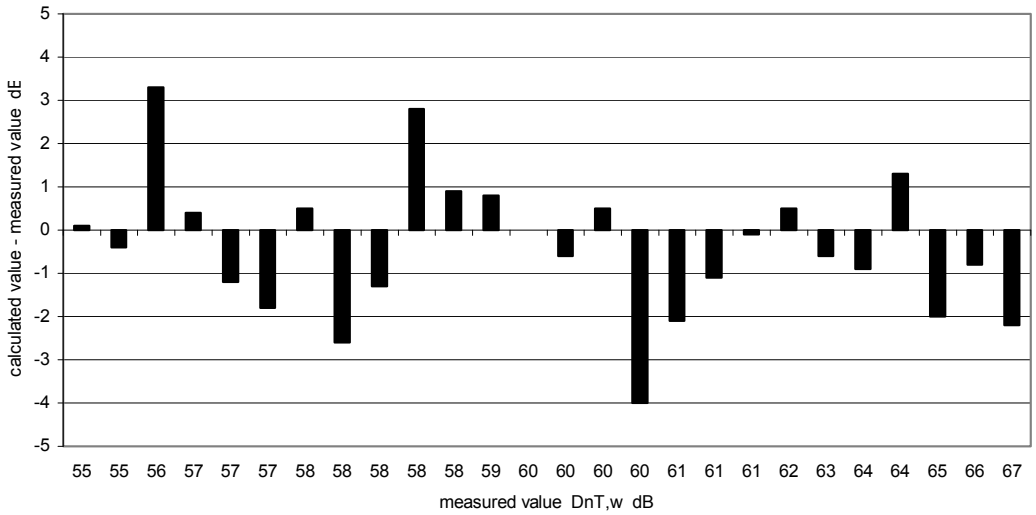

Figure 1: Difference calculated value – measured value for measurements between rooms side by side

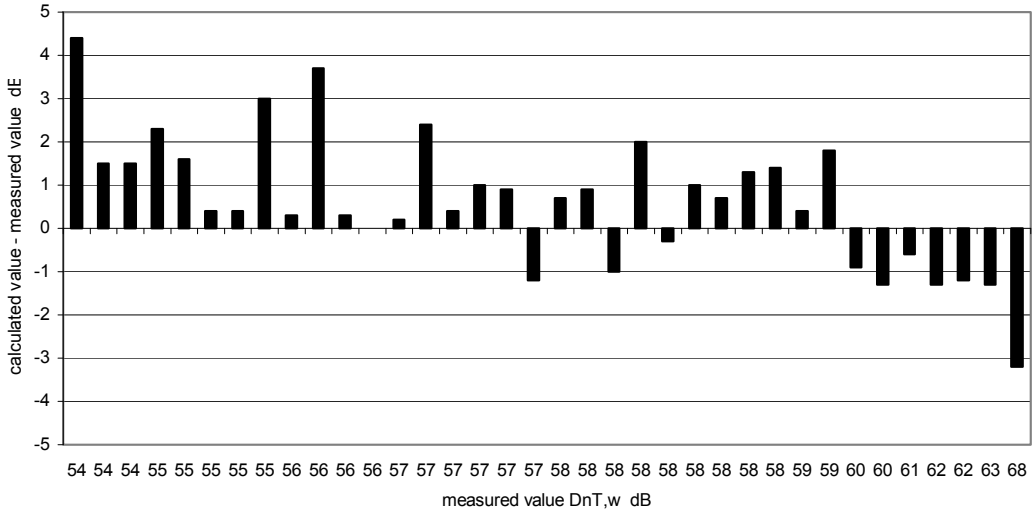

Figure 2: Difference calculated value – measured value for measurements between rooms one on top of the other

The mean values of the difference calculated value minus measured value for all comparisons are given in table 1.

With respect to the good agreement of calculations with the simplified model and measurements it does not seem necessary to use the detailed model in general and it is proposed to shift the detailed model to an Annex.

Table 1: Mean values for the difference calculated value – measured value for $D_{nT,w}$

Measurement	Difference calculated value – measured value (mean values) dB
Measurements in years 1995-1999	
Between rooms side by side	- 0,4
Between rooms one on top of the other	0,6
Measurements 1985	
Between rooms side by side	0,3
Between rooms one on top of the other	0,3

According to these results it did not seem necessary to take care of secondary transmission, which had been considered in the preceding Austrian model (flanking elements R_w-2 dB in the source room). However some Austrian engineers ask now for its reintroduction based on their experience in comparing calculated and measured sound insulation in dwellings.

Within the scope of the investigation calculations were also carried out with the Bastian program to compare the calculated results; they showed that the program used with the simplified method yields the same results as the manual calculation. It provides the results very quickly and also conveniently separated for the single sound transmission paths; thus the planner can identify immediately which sound transmission path plays a decisive role in sound transmission and therefore may require improvement. The program is used in several institutions in Austria to plan sound insulation.

The values for the weighted sound reduction index improvement ΔR_w in EN 12354-1 for heavy walls were found to agree well with results of measurements.

The calculations for ground plans existing in practise showed that some examples for K_{ij} are missing, e.g. a junction with changing of thickness and or mass of the wall at the junction A or example B as shown in figure 3.

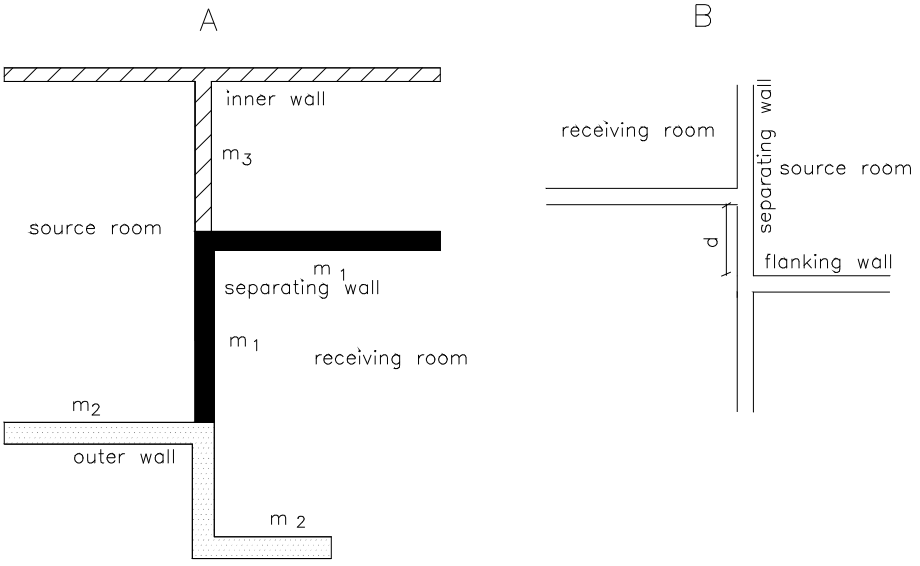

Figure 3: Examples for junctions missing in EN 12354-1

3. ADDITIONAL STATEMENTS IN THE AUSTRIAN STANDARD

It was however found that data for ΔR_w and for ΔL_w for wooden floors are missing in EN 12354-1 and -2. A series of measurements of the airborne and impact sound insulation with a number of wooden or lightweight floor coverings on standard floor nr.1 according to ISO 140-11 were carried out[3]. Relevant data have been included in the Austrian standard.

In EN 12354 no details are given for the flanking transmission in wooden constructions. Also in the Austrian standard no data are given. There is only one example of details of outer wall, floor and partition and their junctions together with the measurement results for the sound insulation in a building. This may be used as an example.

Data for the weighted sound reduction index of a great variety of wooden walls and floors based on measurement results are available in dataholz.com, also some examples for junctions.

As planers don't like to carry out the detailed calculations on the sound insulation resulting from the different transmission paths in separating and flanking elements 2 tables were established by calculations according to EN 12354-1 and inserted in the ÖNORM showing combinations of separating and flanking elements to achieve the required $D_{nT,w} \geq 55$ dB for adjacent rooms and rooms one above the other. The table for achieving the sound insulation between adjacent rooms is shown as an example in figure 4. For 8 different types of partitions (heavy, heavy with flexible lining, light weight double leaf) the appropriate kinds of flanking floor (mass, R_w, floating floor with $f_0 \leq 80$ Hz, resonance frequency f_0 for ceiling), flanking outer wall and flanking inner wall (mass, R_w) without or with flexible interlayer at the junction are described.

Planers and especially building authorities however ask for a hint how to deduce information on the standardized sound level difference only based on the sound reduction index of the separating element. E.g. a statement was proposed *"$D_{nT,w} \geq 55$ dB may be assumed to be fulfilled with the separating element $R_w \geq 55+5$ dB."* From the examples calculated in detail it turned out that the difference $R_w - D_{nT,w}$ may be much higher than 5 dB as the following data from typical Austrian residential buildings show and a relevant statement has been rejected.

For buildings with heavy elements
26 cases rooms one above the other:
$D_{nT,w}$ 55 to 58 dB: difference $D_{nT,w,Dd} - D_{nT,w}$ 5,5 to 10,8 dB, average 8,0 dB
9 cases adjacent rooms:
$D_{nT,w}$ 55 to 58 dB: difference $D_{nT,w,Dd} - D_{nT,w}$ 2,9 to 10,2 dB, average 6,3 dB
9 cases adjacent rooms with higher sound insulation
$D_{nT,w}$ 59 to 63 dB: difference $D_{nT,w,Dd} - D_{nT,w}$ 1,5 to 9,6 dB, average 4,6 dB
For wooden buildings
9 cases rooms one above the other:
R'_w 56 to 66 dB: difference $R_{w,Dd} - R'_w$ 1,7 to 18,7 dB, average 8,0 dB
5 cases adjacent rooms:
R'_w 58 to 62 dB: difference $R_{w,Dd} - R'_w$ 4,0 to 7,9 dB, average 5,4 dB

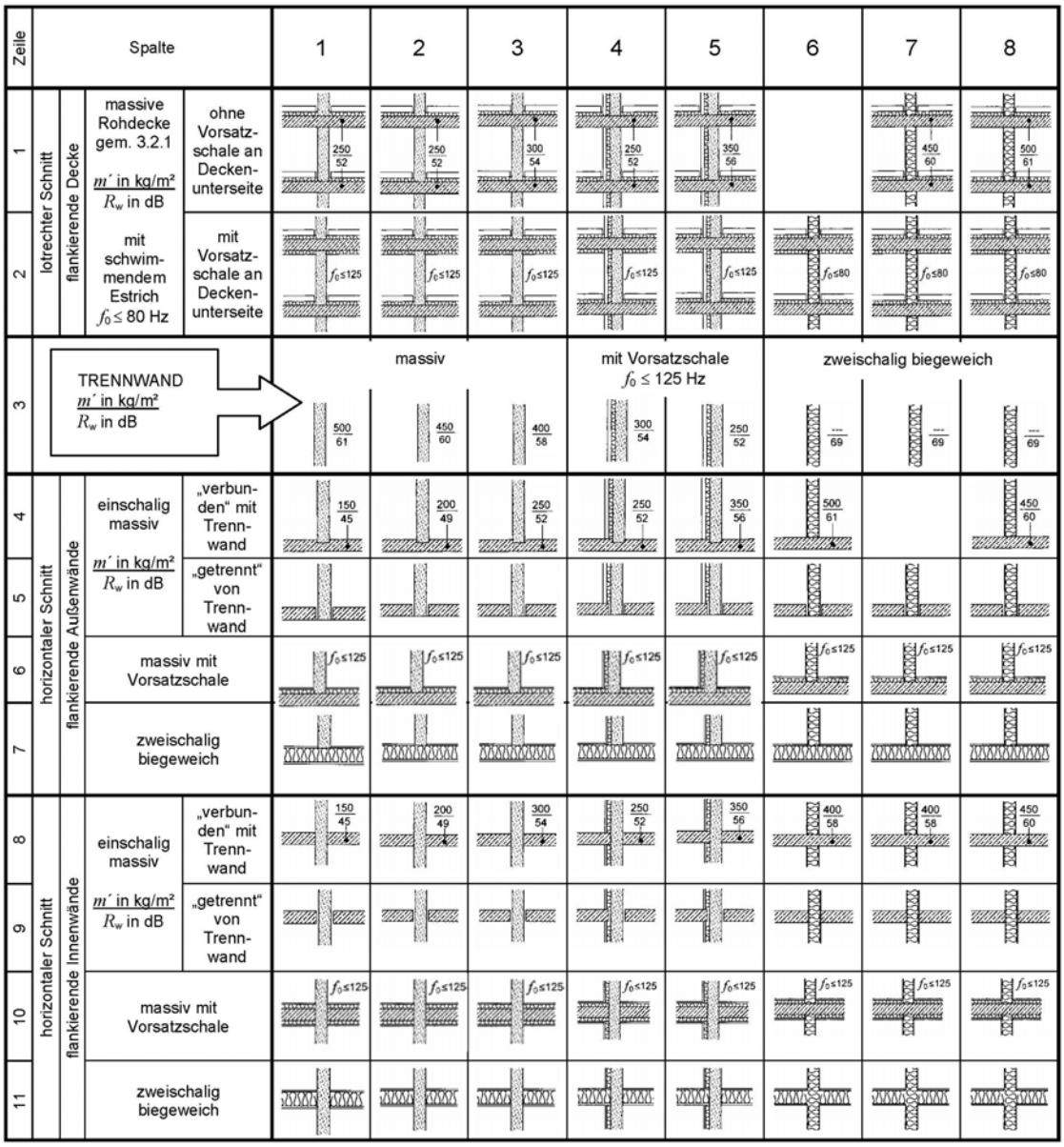

Fig.4: Examples for combinations of partitions and flanking elements to achieve $D_{nT,w} \geq 55$ dB

For junctions of light weight walls from gypsum boards additional details are given in the Austrian standard as shown in figure 5.

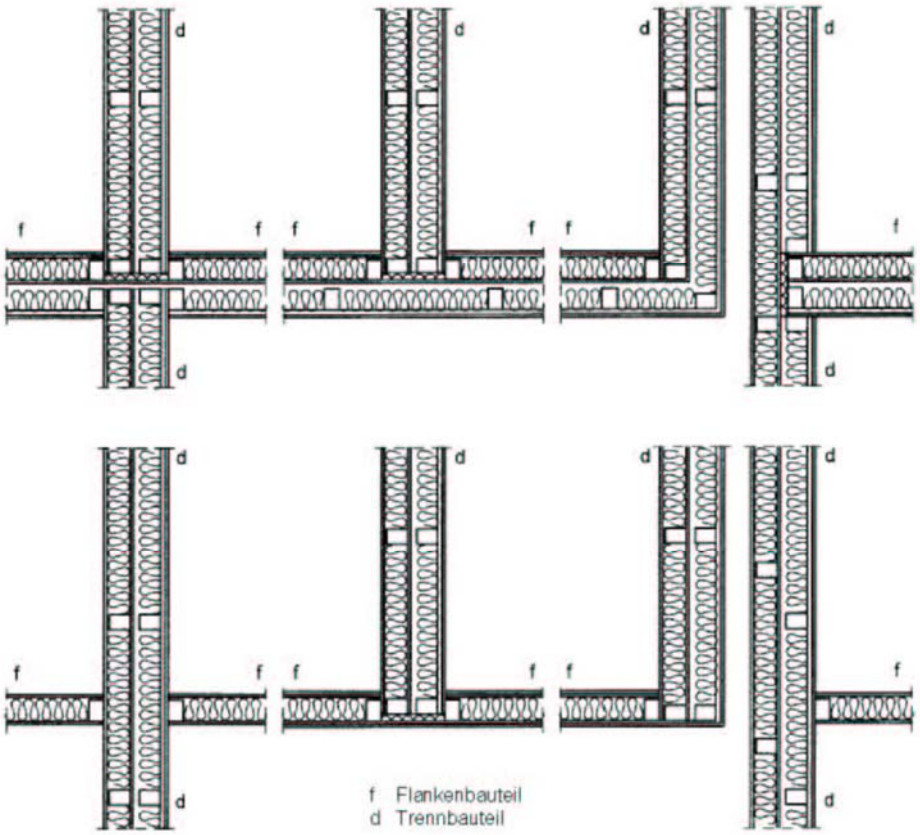

Figure 5: Examples for the correct performance of junctions of light weight walls in the Austrian standard; f flanking element d separating element

4. PROPOSALS FOR ADDITIONAL CONTENTS IN A NEW EN 12354-1 AND -2

Data for wooden constructions, especially floors, should be given as well for airborne sound insulation as well as for impact sound insulation. For the latter also the flanking transmission should be dealt, especially for impact sound insulation.

Measurements on the flanking transmission in wooden constructions have been carried out in Austria for different types of wooden outer walls connected to a concrete floor and the relevant K_{Ff} and $D_{n,f,w}$ (C;C_{tr}) are now available for the planner[4]. $D_{n,f,w}$ (C; C_{tr}) up to 60 (-2;-6) and 66(-2;-9) dB could be achieved.

A special investigation has been carried out in Austria on the flanking transmission of solid wood structures[5]. A special test facility was constructed and sound and vibration measurements carried out on 3 different types of solid wooden floors and 4 different flexible interlayers with different types of fasteners were investigated; an example is shown in fig. 6.

A prediction model was developed following EN 12354-1 with creation of the relevant input data. The junction is defined only by the properties of the flexible interlayers, load and fasteners.

Measured and predicted data for the single number quantities compared quite well with deviations between 0 and 2 dB.

D_n und L_n were measured; $D_{n,w}$ up to 62 dB and $L_{n,w}$ as low as 45 dB were achieved.

The relevant input data should also be inserted in a new EN 12354-1 and 2

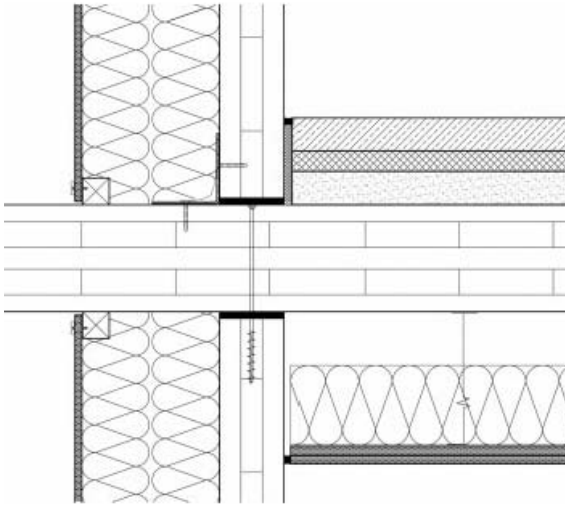

Fig.6: Construction of the wall-floor-junction with fastener

In the existing EN 12354-1 also little information is given on junctions with flexible interlayers. Detailed measurements have been carried out in Belgium[6]; the results should be inserted in a new edition of the EN.

With respect to the flanking transmission in light weight constructions (airborne and structure borne sound) interesting investigations have been carried out in the last years in several countries, especially in France and Netherlands and their results should be inserted in the new edition.

Users in Austria ask for statements on the accuracy of the predictions. The text as it is from the year 2000 described the situation with all the influences very good. However after 10 years work and comparisons of calculations and measurements in many countries it could perhaps be possible to give additional information.

Austrian users are asking also for formulas for all the data given in tables in the EN 12354-1 and -2 for a relieved work with these data.

When working with EN 12354-2 it turns out that there are a lot of references to part 1; this makes the work difficult. It should therefore be considered if the airborne sound insulation and the impact sound insulation should be treated together in one part.

In part 2 data on wooden floors and floor coverings on these are missing. The ΔL_w-data given in part 2 are only to be used in connection with heavy floors. As now ISO 140-11 has been edited and measurements have been carried out data are available and should be inserted. At least in the chapter 4.2.5 “limitations” the measurement of $\Delta L_{t,w}$ for floor coverings on wooden floors according to ISO 140-11 and the work with data achieved by this should be mentioned.

In part 1 as well in part 2 spectrum adaptation terms are sparsely mentioned. As these have become more important in the last years, especially also these for 50 – 3150 or 50-2500 Hz and have been included also in requirements in standards there should be some data. A lot of data on spectrum adaptation terms have been compilated[7].

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