SOUND INSULATION IN AUSTRIAN MULTIFAMILY HOUSES

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ABSTRACT

According to the Austrian standard the weighted standardised sound level difference $D_{nT,w} \geq$ 55 dB and the weighted standardised impact sound level $L'_{nT,w} \leq$ 48 dB is required in multifamily houses. In order to check whether calculations according to the new European standards are applicable for the Austrian type of constructions results of calculations and measurements of the sound insulation in a series of residential buildings have been compared. The sound insulation achieved in the buildings was in the range of $D_{nT,w}$ = 54 - 68 dB. The types of constructions used are heavy in-situ concrete floor constructions with a floating floor with $R_w \geq$ 65 dB and separating walls with a lining of gypsum boards on mineral wool with R_w = 61 - 67 dB. With these separating elements the sound transmission via flanking elements (especially in the outer walls, designed for high heat insulation) is important.

INTRODUCTION

According to the **Austrian standard** ÖNORM B 8115-2 (1) the following sound insulation is required between dwellings:

weighted standardised sound level difference $D_{nT,w} \geq$ 55 dB
weighted standardised impact sound level $L'_{nT,w} \leq$ 48 dB.

These requirements are rather stringent compared with the standards in other European countries. They are used in most of the 9 Austrian „Länder“ (building is under the authority of the „Länder“-governments), especially for subsidised residential buildings. In the Land Steiermark the fulfilment of the requirements has to be shown by a detailed calculation of the sound insulation to be expected before the start of the construction work and after the building is completed the sound insulation is measured in several samples by a measuring team established in the office of the government. In the Land Oberösterreich also the sound insulation is measured in a lot of samples in the buildings by a measuring team of the office of the government. So the fulfilment of the requirements is ensured.

Until now the calculations have been performed based on the standard ÖNORM B 8115-4 (1). This standard has now to be withdrawn with respect to the European standards EN 12354-1 and EN 12354-2 (2). A new edition of the ÖNORM B 8115-4 is being prepared based on these European standards. In order to be sure, that the new European calculation scheme is applicable for the Austrian type of constructions and the calculation results comply with the sound insulation in practice (measured in the building) it was decided to carry out calculations for a series of residential buildings and compare the results with the results of measurements in these buildings. By order of the Austrian Ministry for economic affairs the author carried out calculations on the sound insulation in 28 multifamily houses constructed in the last 10 years and with this got an insight into the types of construction now used in Austria and the sound insulation achieved with these.[1)]

AIRBORNE SOUND INSULATION AND RELEVANT CONSTRUCTIONS

Fig.1 shows the **weighted standardised sound level difference $D_{nT,w}$** measured between adjacent flats with the partition as the separating element and fig.2 the $D_{nT,w}$ -values between flats one above the other with the floor as the separating element. One can see, that the $D_{nT,w}$ – values between the adjacent rooms are in the range of 55 – 67 dB and between rooms one above the other in the range of 54 – 68 dB. So the requirement is fulfilled and in most cases favourably exceeded.

The **partition walls between flats** are mainly 25 or 30 cm brickwork (heavy hollow bricks „Schallschutzziegel“) or in 3 cases concrete, all with a flexible lining of gypsum board on mineral wool 3 – 5 cm thick. The layer of mineral wool is necessary to fulfil the high requirement on heat insulation between flats (to avoid „heat theft“). With the lining on mineral wool the walls have a weighted sound reduction index of R_w = 61 – 67 dB (calculated values based on the measured sound reduction index of the wall or an estimation of this based on mass per unit area and the ΔR_w – values according to Annex E in EN 12354-1).

The **floor construction** is in all buildings an in-situ concrete solid floor 18 cm (in a few cases 16 cm) thick with a 5 – 10 cm thick layer of sand, fine gravel, pumice or similar, glued with cement.[2)] On this floor construction a floating floor of 6 cm concrete on a resilient layer of 25 – 35 mm mineral wool (dynamic stiffness 5 – 9 MN/m^3) or polystyrene with low dynamic stiffness is laid. With the mass per unit area of 500 – 600 kg/m^2 for the concrete floor construction with the additional layer and another 120 kg/m^2 for the floating floor the sound reduction index of the floor is very high ($\geq$ 65 dB). With the high mass per unit area the floor ensures also a high vibration reduction index for the junction in the floor flanking the partition between the flats on the one hand and also for the junction in the (light weight inner) walls flanking the floor on the other hand.

The **partitions within a flat** are from 10 – 12 cm hollow bricks, or 25 cm hollow brick if load bearing or in some cases walls from gypsum boards.

The **outer walls** (flanking the partition walls and the floors) are mainly from 38 cm hollow bricks, designed for high heat insulation (to fulfil the requirements on heat insulation for outer walls), in a few cases concrete with heat insulation from wood wool slabs on both sides or jacket blocks from wood chips concrete with concrete core, or 38 cm hollow blocks from light weight concrete or 30 cm hollow bricks or hollow concrete blocks with an outside heat insulation of polystyrene, The weighted sound reduction index of the walls from hollow bricks is R_w = 49 – 53 dB; it is much lower than to be expected from the mass because of the design with a great number of small long slits between small layers of brick, which cause resonances with a reduced sound reduction index, mainly in the frequency range of 1000 – 2000 Hz. The walls from concrete blocks or jacket blocks have R_w = 52 – 58 dB.

So the sound transmission via the flanking outer walls is in most cases the main sound transmission path between adjacent rooms and between rooms one above the other, especially in rooms with large areas of outer walls. Also the resonance effects of the bricks in the flanking outer walls are predominant in the sound level difference. However with the high

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1) For the comparison calculations for further 17 different cases of adjacent rooms and 6 different cases of rooms one above the other in 8 houses constructed before 1985 were carried out.

2) In this layer pipes of the central heating and other technical equipment are embedded.

vibration reduction index for the junctions caused by the high mass of the separating elements the sound level difference for the flanking paths is also sufficient.

In fig. 3 the $D_{nT,w}$ – values calculated for the different sound transmission paths between adjacent rooms and in fig.4 between rooms one above the other and the sum of all paths are shown for some examples. The figures show that in most cases the separating element is not the dominant sound path.

COMPLIANCE CALCULATION - MEASUREMENT

The compliance of measured and calculated $D_{nT,w}$ – values was very good. On average the difference calculated value – measured value was –0,4 dB for adjacent rooms and 0,3 dB for rooms one above the other (details on the results see fig.5). All calculations were carried out with the simplified model (calculation with the single number quantities only).

IMPACT SOUND INSULATION

The impact sound insulation has also been measured in a number of samples in the buildings. The weighted standardised impact sound level is in the range of $L'_{nT,w} = 41 – 45$ dB and with this below the maximum permissible level of $L'_{nT,w} = 48$ dB. The values calculated by the simplified model according to EN 12354-2 are in all cases considerably lower than the measured values. That may be caused by the flanking transmission in the outer walls or by airborne sound transmission of the sound level caused by the tapping machine in the source room;[3)] it could be possible also, that the formula for the equivalent weighted normalised impact sound pressure level $L_{n,eq,w}$ versus mass per unit area of the load bearing floor is not applicable for high masses > 500 kg/m^2 or the ΔL_w-values are not independent from the mass of the load bearing floor, where they are applied. This has to be investigated.

LIGHT WEIGHT WOOD CONSTRUCTION

Apart from the usual houses with massive walls and floors a research project with multifamily houses in light weight wood constructions was carried out in Steiermark. The sound insulation between adjacent flats was with $D_{nT,w}$ = 64 and 69 dB measured comparably high due to a construction taking specific care of the sound insulation with a double leaf wall (chipboard and gypsum board) on separate studs and a complete separation of all flanking elements. The sound insulation between flats in vertical direction is $D_{nT,w}$ = 56 dB with a load bearing floor of wooden beams and a floating wooden floor and a suspended ceiling from gypsum board. No calculations have been carried out for the sound insulation of that construction.

ACKNOWLEDGEMENTS

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[3)] Even with detailed calculations in third octave bands taking into account also the transmission of the airborne sound of the tapping machine a difference of about 5 dB was left between measured and calculated value.

REFERENCES

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[2] *Building Acoustics - Estimation of acoustic performance of buildings from the performance of elements*, Part 1: Airborne sound insulation between rooms ; Part 2: Impact sound insulation between rooms, prEN 12354

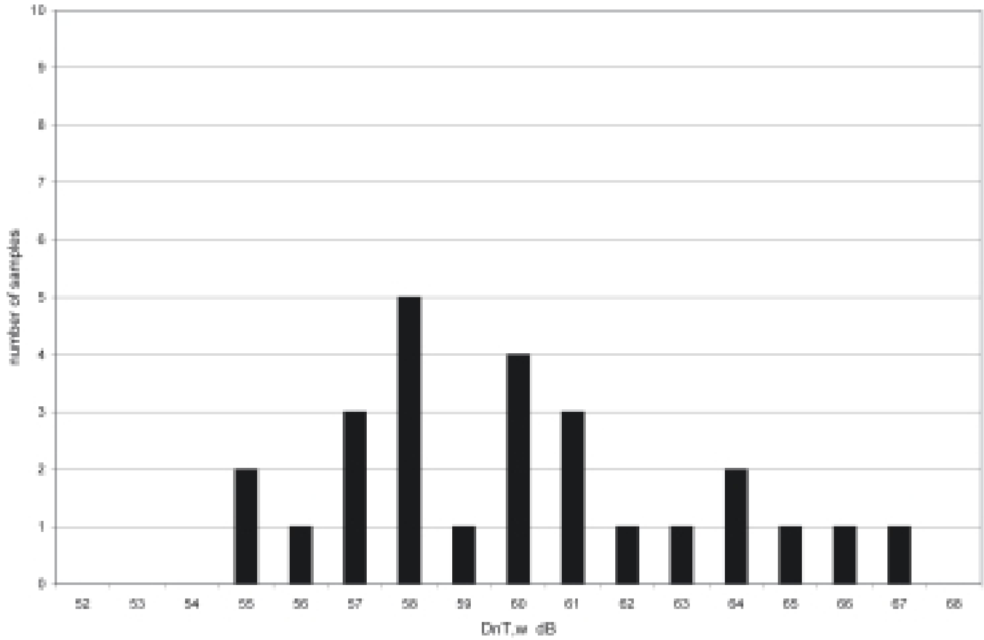

Fig. 1: weighted standardised sound level difference between adjacent rooms

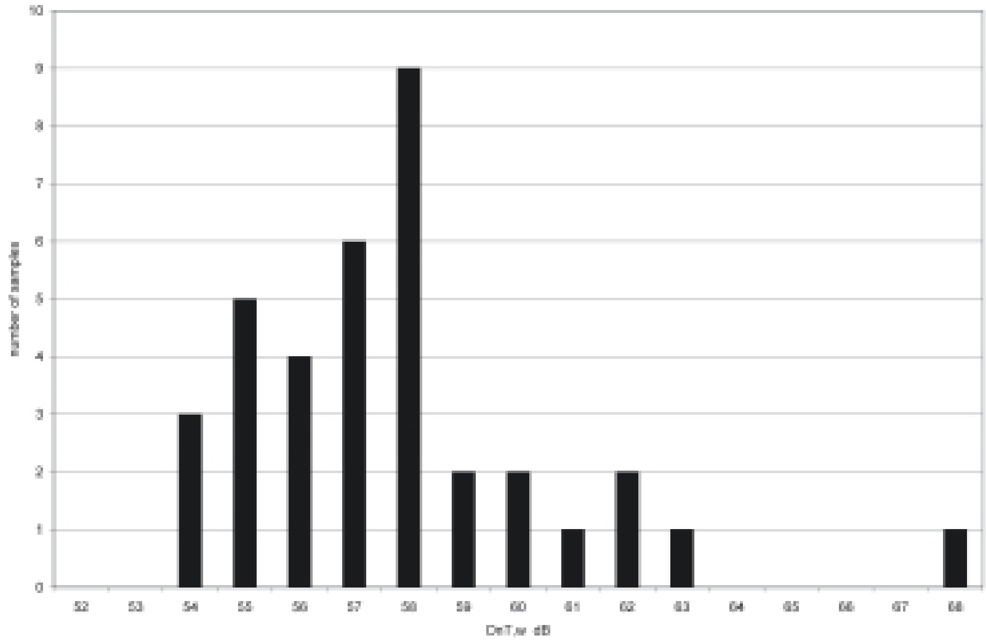

Fig. 2: weighted standardised sound level difference between rooms one above the other

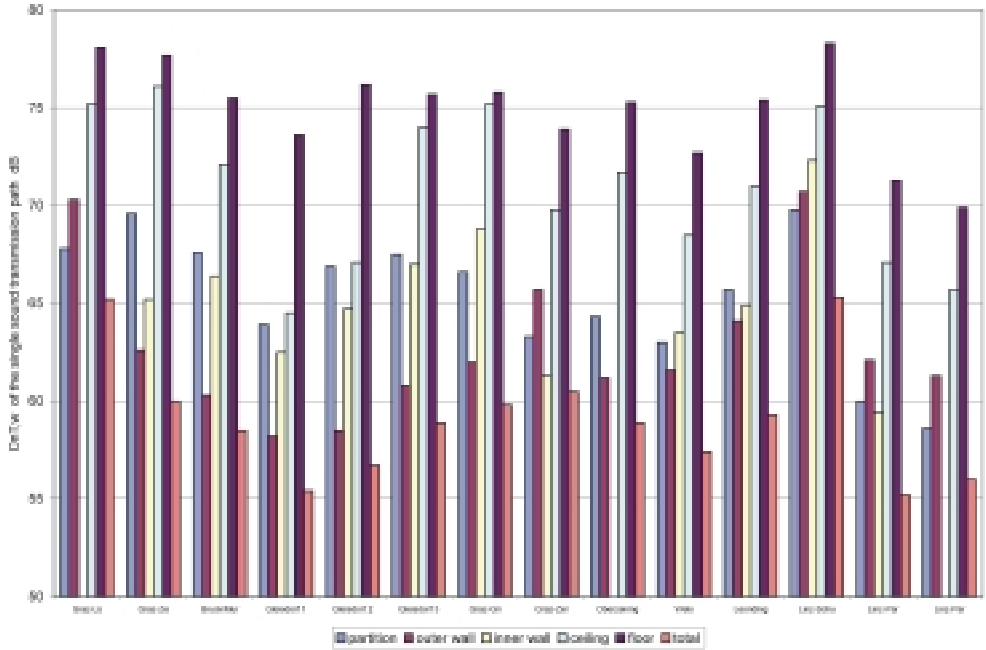

Fig. 3: $D_{nT,w}$ -values for the different single sound transmission paths adjacent rooms

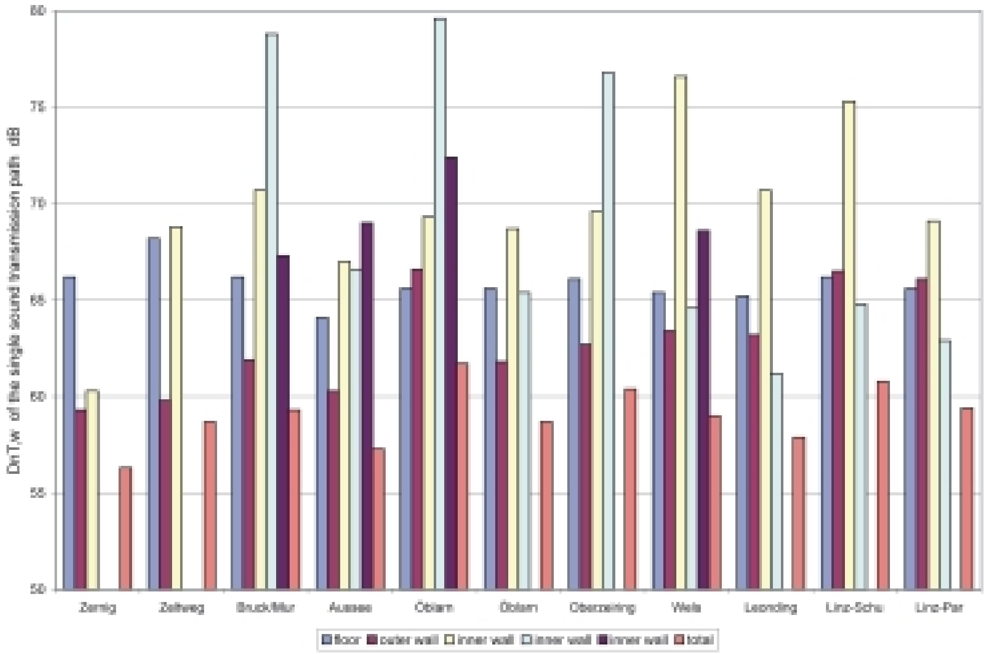

Fig. 4: $D_{nT,w}$ -values for the different single sound transmission paths rooms one above the other

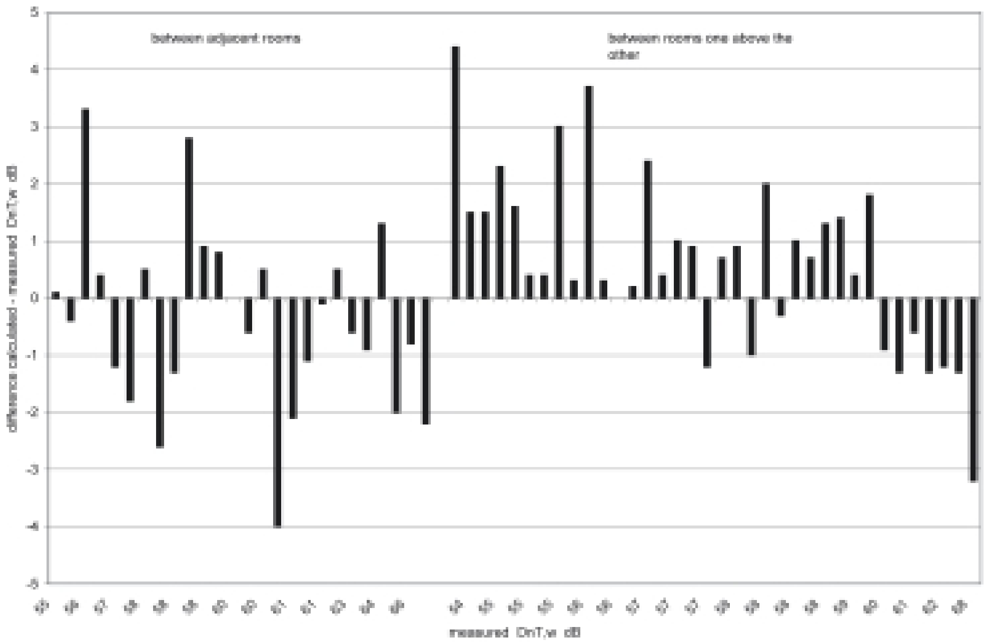

Fig.5: difference between the calculated and the measured $D_{nT,w}$ -values