

Requirements for impact sound insulation between dwellings from the point of view of acoustical comfort of inhabitants

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Impact sound penetrated from the neighbouring dwellings is assessed as the most annoying noise in the multi-storey housings. It is especially observed in the buildings, where flats are arranged individually with lightweight walls, placed on the same plate of massive floor. The floor is usually finished with wooden panels putting on the insulation layer. The weighted normalized impact sound pressure level $L'_{n,w}$, used in many countries for formulate the legal requirements, is not well correlated with subjective evaluation of acoustical comfort. The paper presents some examples of building constructions where, in spite of relatively low value of $L'_{n,w}$ (≤ 50 dB), the high annoyance of impact noise becoming widespread from all directions is observed. This problem is discussed against the background of Polish requirements and their modification planned in the near future.

1 Introduction

The one of the basic requirements in the European Directive 89/106/EEC [1], concerning “Noise Protection” is formulated as follows:

“Construction objects have to be designed and executed in such a way that the noise which affects the residents or the people in the vicinity of such objects does not exceed the level of health hazard and that it allows them to sleep, rest and work in satisfactory conditions”.

In order to be equal to these requirements, it is necessary to aim for the level of the standard requirements at a possibly maximum degree ensure the acoustic comfort of the buildings, recognized by most of its users.

This paper is restricted to the evaluation of the impact sound insulation in residential buildings. Survey studies carried out in many countries show that the impact sound coming from neighbours is one of the most annoying and is often audible even if the standard requirements are fulfilled. This means that the level of standard requirements is inadequate to social feeling.

2 The current Polish requirements for impact sound insulation in residential buildings

The parameter used in Poland for the standard evaluation of impact sound insulation is the weighted normalized impact sound pressure level $L'_{n,w}$. The spectrum adaptation term C_1 introduced in the standard EN ISO 717-2: 1996 [2] has not been taken into account due to the lack of a sufficiently clear relationship between the subjective evaluation of

insulation between rooms and the technical evaluation of floors expressed with the index $L'_{n,w} + C_1$.

The current requirements concerning the impact sound insulation of dwellings in residential buildings, according to the polish standard PN-B-02151.03:1999 [3] are presented in Table 1. It is particularly worth focusing attention on the insulation between compartments neighbouring with one another not only in vertical, but also horizontal and diagonal direction.

Table 1: Requirements for the impact sound insulation in residential buildings (acc. to PN-B-0251-3:1999)

Function of separated spaces		max $L'_{n,w}$ [dB]
All paces in apartment	All spaces of the another apartment	58 ¹⁾
	Common corridor, stairways	53 ²⁾
	Technical room	58 ³⁾
	Shop, service room etc. $L_A < 70$ dB	53 ³⁾
	Shop, service room etc. $L_A = 70 \div 75$ dB	48-53 ³⁾
Room	All spaces of the same apartment	58

¹⁾ For floors in kitchens and bathrooms – it applies to the transmission in horizontal and diagonal directions

²⁾ It refers to the horizontal and diagonal directions

³⁾ It concerns the transmission from the floor of the noisy room to the space in apartment regardless of its position

Adherence to standard requirements for such directions of propagation is particularly important in buildings with lightweight walls and massive floors with floating floors. The incorrect building of these walls, without the appropriate break, leads to enlarging the flanking sound transmission, and as a consequence, to substantially lowering the insulation between compartments. An example of this is the result of a measurement carried out in one of the residential building in which the floors were made of 250mm concrete with floating floor and different floor surfaces. Most of the walls (in this between dwellings) were made as lightweight gypsum board walls. The weighted normalized impact sound pressure level $L'_{n,w}$ measured in the horizontal direction, between the corridor on the stairway and the drawing - room (connected with the hall and kitchen), was 79 dB, whereas the value permitted by the standard is 53 dB. The reason for such a dramatically bad result was the building of a lightweight wall, separating these compartments, directly on the floating floor placed on a common floor (see Figure 1a).

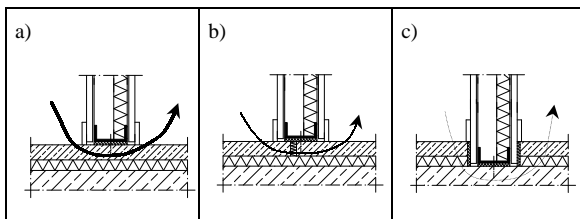


Figure 1: Different ways of building of the lightweight walls on the floor slabs with floating floors

3 Current standard requirements and the subjective evaluation of impact sound

The level of Polish standard requirements on the background of regulations of other European countries is relatively low. In many countries it is required (or recommended) that the weighted normalized impact sound pressure level $L'_{n,w}$ should not exceed 53 dB, whereas the basic requirement in Poland is set at the level of $L'_{n,w} \leq 58$ dB.

The insufficient, in the feeling of the dwellers, impact sound insulation between dwellings, has been made evident in the results of survey, conducted in Poland in the 1980s and 1990s [4,5]. It was shown at the time that the audibility of impact sound, despite fulfilling

standard requirements, is at ca. 60%, and even a slight deficiency of the impact sound insulation (by 1-2 dB) causes audibility in practically 100% of the examined cases.

Many measurements of impact sound insulation in newly erected residential buildings have been carried out in the last three years [6]. It was found that impact noise from neighbours is evaluated as a nuisance even in situations when the standard requirements are fulfilled in excess.

This may be explained by increased social expectations concerning the acoustic comfort of dwellings, but also by the fact that in practically all of the examined dwellings the level of acoustic background was very low, reaching as little as 23-25 dB (A) during the day.

Figure 2 presents the results of measurements of normalized impact sound pressure level L'_n for floor between dwellings of the following structure: reinforced concrete 250mm + floating floor (with 20mm mineral wool and 20mm set board) + wooden floors on backing. All of the walls (apart from the massive 240mm thick external wall) were made of C-100 steel profiles, filled with 50mm mineral wool and lined with gypsum boards 12,5mm. The weighted index for this case was $L'_{n,w} = 50$ dB, therefore the standard requirements were fulfilled in excess of 8 dB. Despite such a good result, the great nuisance of impact sound from neighbours (particularly footsteps) had been recorded.

A comparison of the results of the measurements of the sounds of footsteps "above", reaching the dwellings being examined and the background noise level normally found in these dwellings may explain this situation. It is clearly seen that in the frequency range between 50 Hz and 250 Hz the sound pressure level of footsteps noise is often up to 10-20 dB higher than the sound pressure level of the background. This is also reflected in the values of the A-weighted sound levels of impact and background noise. The level of footsteps noise exceeds the background level by 10 dB(A). The difference is large to the extent that it explains the nuisance of impact sound even in a situation when it is of short duration (Perhaps it should be considered as a non-steady noise? However, it would then be necessary to have a source that would better reflect the character of the footsteps sound than the normalized tapping machine used up to now).

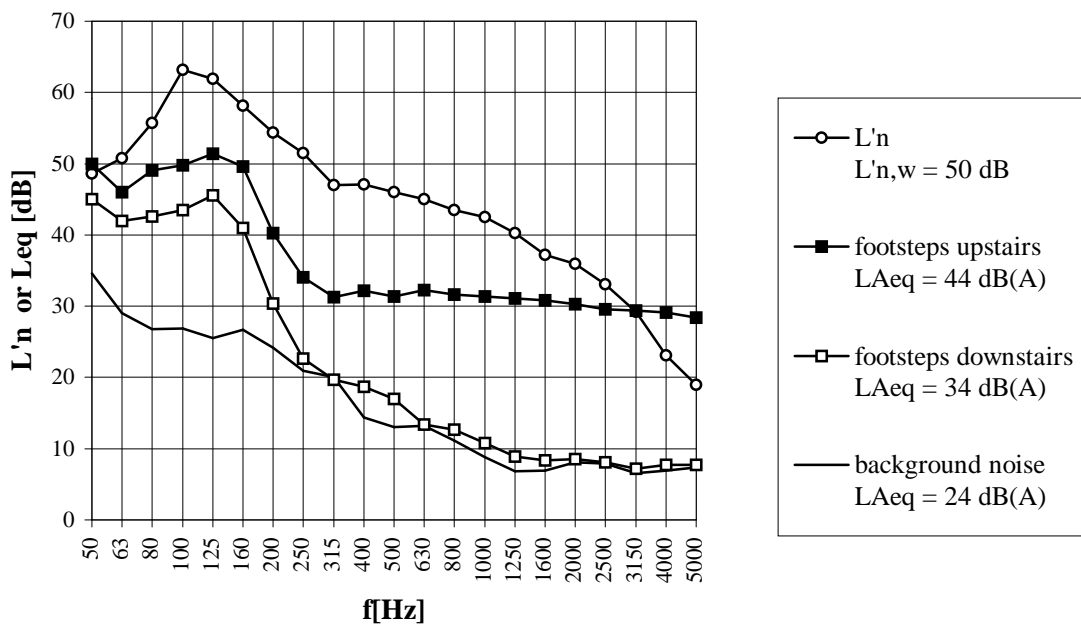


Figure 2: The measurement results of the normalized impact sound pressure level L'_n in comparison with the equivalent sound pressure level of the footsteps and background noise

4 Proposed changes in formulating Polish standard requirements regarding impact sound insulation

The requirements concerning impact sound insulation have been established assuming that the permitted equivalent sound level in residential buildings during the day is $L_{Aeq} = 40$ dB(A) and at night $L_{Aeq} = 30$ dB(A). A similar assumption was adopted in setting the requirements of external wall insulation. The adoption of these permitted values is now often considered as too high by the dwellers.

At the same time, in connection with the quite general use of external walls with insulation of around $R_{Atr} = 35 \pm 40$ dB, the level of the acoustic background in buildings located in areas with a level below 60 dB(A) is much lower than the permitted level and is equal or less 25 dB(A). Noise coming from neighbours (in this impact noise) in such instances are much more audible and more often considered as annoying.

The changes being prepared in Polish standard requirements concerning impact sound insulation of dwellings refer to two issues:

1. adopting, following the example of some European countries, insulation classes ensuring different acoustic comfort,
2. making requirements concerning impact sound insulation between dwellings dependent on

the level of the acoustic background in the building (a similar approach should also apply to airborne sound coming from neighbours).

A proposition of main requirements (for insulation between rooms placed vertically) is presented in Table 2. Additional requirements concerning horizontal and diagonal insulation and insulation in special situations (like neighbourhood of service room) will be appropriately established in line with the general principle adopted for the main requirements.

It should be pointed out that for the time being this is a proposal, which will be subjected to discussion and a questionnaire survey in the framework of normalisation works.

Table 2: Proposal for impact sound insulation requirements for residential buildings

Impact sound classification of dwellings	Maximum of $L'_{n,w}$ [dB] in depending on L_{Aeq} [dB] of background noise		
	day ≥ 40 night ≥ 30	day = 35 night = 25	day ≤ 30 night ≤ 20
Class I (minimum)	58	53	48
Class II (medium quality)	53	48	43
Class II (comfortable)	48	43	38

5 Summary

The need to amend Polish requirements concerning impact sound insulation in residential buildings results from numerous cases of lack of acceptance for the level of sound comfort of dwellings on the part of the habitants. Unfortunately, there is no clear correlation between the subjective evaluation and the single number evaluation indices, set in line with EN ISO 717-2:1999 currently in use. The reason for this is most probably the fact that the standard tapping machine used in accordance with EN ISO 140-7:1998 produces less low frequency sound energy than natural footsteps, and the reference curve for setting the evaluation index does not consider this. This situation may change following the introduction of a new, modified source of impact noise in the standards.

A certain "lead" in finding the correlation between subjective and objective evaluation of impact noise would be to make the level of requirements dependent on the degree of exceeding the A-weighted level of background noise. Such a correlation has been statistically shown in questionnaire surveys concerning non-steady noise, such as elevator noise [4,5]. The proposal of changing the polish requirements relating to the impact noise insulation in buildings takes into account this fact.

It may also be assumed that reducing the level $L'_{n,w}$ by 5dB will improved the subjective evaluation of acoustical comfort of dwellings and will give protection against unbearable disturbance. But raising the requirements also has an economical aspect. This is why the present main requirement $L'_{n,w} \leq 58$ dB will be left as the minimum, and two new classes, ensuring greater sound comfort, will be used in the case of dwellings of a higher standard.

References

- [1] Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products
- [2] EN ISO 717-2:1996, 'Acoustics – Rating of sound insulation in buildings and of building elements. Part 2: Impact sound insulation'
- [3] PN-B-02151-3:1999, 'Akustyka Budowlana – Ochrona przed hałasem w budynkach – Izolacyjność akustyczna przegród w budynkach oraz izolacyjność akustyczna elementów budowlanych – Wymagania' (Building Acoustics – Noise protection in buildings – Sound insulation in buildings and of building elements – Requirements)
- [4] A.Izewska, 'Ocena subiektywno-objektywna jakości akustycznej mieszkań w budynkach prefabrykowanych' (Subjective – objective evaluation of acoustic quality of dwellings in prefabricated buildings), doctoral thesis, ITB, Warsaw, 1993 (in Polish)
- [5] A.Izewska, 'Prognozowanie klimatu akustycznego mieszkań na etapie projektowania' (Prediction of the acoustic climate of dwellings on the phase of designing), project of KBN No 7 T07E 016 17, Warsaw, 2001 (in Polish)
- [6] B.Szudrowicz, 'Ocena izolacyjności akustycznej w budynkach na podstawie pomiarów' (Evaluation of sound insulation in buildings on the basis of measurements), Research Report of ITB, Warsaw, 2004 (in Polish)