Applied Acoustics 142 (2018) 18–28

Contents lists available at ScienceDirect

Applied Acoustics

journal homepage: www.elsevier.com/locate/apacoust

An engineering method to measure the impact sound reduction due to soft coverings on heavyweight floors

Katarzyna Baruch [a,*], Agata Szeląg [b], Jarosław Rubacha [a], Kamila Hałoń [a]

[a] AGH University of Science and Technology, al. A. Mickiewicza 30, 30-059 Kraków, Poland
[b] Tadeusz Kościuszko Cracow University of Technology, ul. Warszawska 24, 31-155 Kraków, Poland

A R T I C L E I N F O

Article history:
Received 28 February 2018
Received in revised form 2 August 2018
Accepted 6 August 2018

Keywords:
Impact noise
Improvement of impact sound insulation
Resilient surface layer
Flexible covering
Simplified method

A B S T R A C T

In order to measure the improvement of impact sound insulation ΔL due to a floor covering in accordance with ISO 10140 standard, a specialised measurement facility is required. As a consequence, such measurements become fairly expensive and available only to those who have access to a specialised laboratory. Therefore, the authors propose an engineering method to measure the ΔL value in the case of soft coverings placed on heavyweight floors. This method enables the replacement of extensive test facilities with one room with a heavyweight floor and a mobile insulation case inside. The inside of the case acts as a source room; the tapping machine and the test sample are placed inside the case, which separates the airborne sounds from the structure borne sounds. The measurement procedure described in ISO 10140 standard is adopted – ΔL is determined by the difference between the sound level outside the case with and without the test sample. In this article, the proposed engineering method is thoroughly delineated and verified with theoretical and energy (SEA) analyses. Next, the results of experimental tests are presented – the reduction of impact sound on four different groups of samples measured in three different rooms. The obtained results are compared with the corresponding ΔL values measured according to ISO 10140 standard. This comparison shows a very strong convergence between the curves of impact sound reduction obtained by both methods. Based on all the above findings, it is stated that the presented engineering method enables accurate measurements of impact sound reduction of heavyweight floors due to soft coverings within the range of uncertainty and application. Due to the reduced measurement facilities in comparison with the ISO standard, the engineering method can be a useful tool in the process of designing and improving products such as soft floor coverings.

© 2018 Elsevier Ltd. All rights reserved.

1. Introduction

Methodology for laboratory measurements of impact sound reduction due to floor coverings is thoroughly delineated in ISO 10140-3 [1]. Moreover, ISO 10140-1 [2] describes various categories of tested floor coverings. Among these, there are soft coverings classified as category I: "flexible coverings which may be installed loosely or by adhesion to the floor surface" – examples of such coverings are carpets, PVC and linoleum. The parameter ΔL, which describes the improvement of impact sound insulation achieved through the use of any floor covering is defined in ISO 10140-3 [1] as:

$$\Delta L = L_f - L_{f+c}, \quad (1)$$

where L_f is the impact sound level of a bare floor and L_{f+c} is the impact sound level of a floor with a covering. As required by the standard, to measure the ΔL value, a standardised reverberation chamber separated from the second measurement chamber with a standard floor should be used. Since a specialised laboratory is necessary to conduct such measurements, it becomes much more expensive and less available to those who do not have access to standard coupled chambers. Therefore, some scientists are developing alternative methods of measuring the ΔL parameter that do not require specialised rooms and floors. Among these, there are methods that include measurements of impact sound reduction due to soft coverings.

The first such attempt was made by Sonntag [3]. He proposed a short test method which allows determination of the weighted reduction of the impact sound pressure level ΔL_w based on the value of the maximum acceleration of a 500 g hammer falling from a height of 4 cm on a soft layer. The exact requirements for measurement procedures and equipment are described in the German

* Corresponding author.
E-mail address: kbaruch@agh.edu.pl (K. Baruch).

https://doi.org/10.1016/j.apacoust.2018.08.006
0003-682X/© 2018 Elsevier Ltd. All rights reserved.

standard TGL 10688/13 [4]. Unfortunately, using the TGL test method, it is possible to determine the weighted parameter ΔL_w only – with no information about the entire spectrum of the response. Moreover, Bethke [5] showed that this method gives the values of ΔL_w understated by around 3 dB compared to the results obtained according to ISO 10140-3 [1].

Another idea to simplify the measurement procedure given in ISO 10140-3 [1] was presented by Sommerfeld [6]. His method was fully described in ISO 16251-1 [7]. It consists of measuring the difference between the acceleration level of the bottom surface of a small concrete floor, with and without a studied floor covering, excited from the top by a standard tapping machine. Based on the obtained acceleration difference, one may determine the ΔL parameter and then calculate the quantity ΔL_w according to ISO 717-2 [8]. The ISO 16251-1 method was verified in detail. Firstly, various test conditions were examined, including different accelerometer and tapping machine positions or different numbers of excitations and registration points [9,10]. The possibility of using the method for samples of ISO 10140-1 [2] categories II and III was also tested; however, it turned out that the method proved to be unsuitable for such samples because of their 'plate-like' behaviour [9,10]. Furthermore, the measurement uncertainty of the results obtained according to ISO 16251-1 [7] was also determined [11]. Finally, it was verified whether the measurements might be carried out using floors other than heavyweight floors [12]. This research referred to Sommerfeld's work [6], who also presented an analysis of the influence of tested floors on the obtained results. Both studies showed a large discrepancy between the results of measurements conducted on lightweight and heavyweight floors. On the other hand, quite consistent results were obtained in the case of timber-concrete floor. In summary, although the ISO 16251-1 [7] method gives fairly accurate values of impact sound reduction due to the placement of soft coverings on heavyweight floors, it requires the construction of a specialised measurement setup. Moreover, this procedure significantly differs from that presented in ISO 10140-3 [1], i.e. the tests are not based on sound pressure level measurements but on vibration measurements.

A completely different approach to measurements of impact sound reduction due to soft coverings was presented by Godinho et al. [13]; however, their method also requires building a specialised measurement setup, specifically, a miniature reinforced-concrete reverberation chamber. During measurements, a standard tapping machine is located on the top of this chamber and the impact sound levels are measured inside the chamber in accordance with ISO 10140-3 [1]. The disadvantage of this method is the difference in values of the ΔL parameter for low frequencies compared to the results obtained from the tests conducted according to the ISO 10140-3 standard [1]. This is caused by unfavourable resonance phenomena occurring in the small-sized chamber as well as by low airborne sound insulation of the chamber due to the mounting door located in the chamber wall.

The authors of this paper propose an alternative method to measure impact sound reduction due to soft coverings placed on heavyweight floors. The main advantage of this method lies in the fact that during the measurements, standardised adjacent rooms are not required; thus, the measurements can be performed even outside the laboratory. The measured parameters remain unchanged in relation to those described in ISO 10140-3 [1], which ensures a better comparability of the results with the standardised measurements. Finally, the proposed method has no frequency restrictions. Although the results of this method may not be used for a formal certification of measurement or classification process – the method is not authorised by ISO – they may be used for research and industrial purposes.

2. Description of the engineering method

The presented engineering method to measure the influence of soft coverings on impact sound reduction may be a widely available alternative for the laboratory measurements described in ISO 10140-3 [1]. The crucial difference between the proposed method and the standard approach concerns the space where the measurements are conducted. Required by the ISO standard two vertically adjacent rooms separated by a heavyweight standard floor in the engineering method are replaced by any measurement room with a heavyweight floor with a mobile insulation case inside. This exchange was possible because the case acts as a source room where the impact source (a standard tapping machine) and a tested sample are located (Fig. 1). Instead of

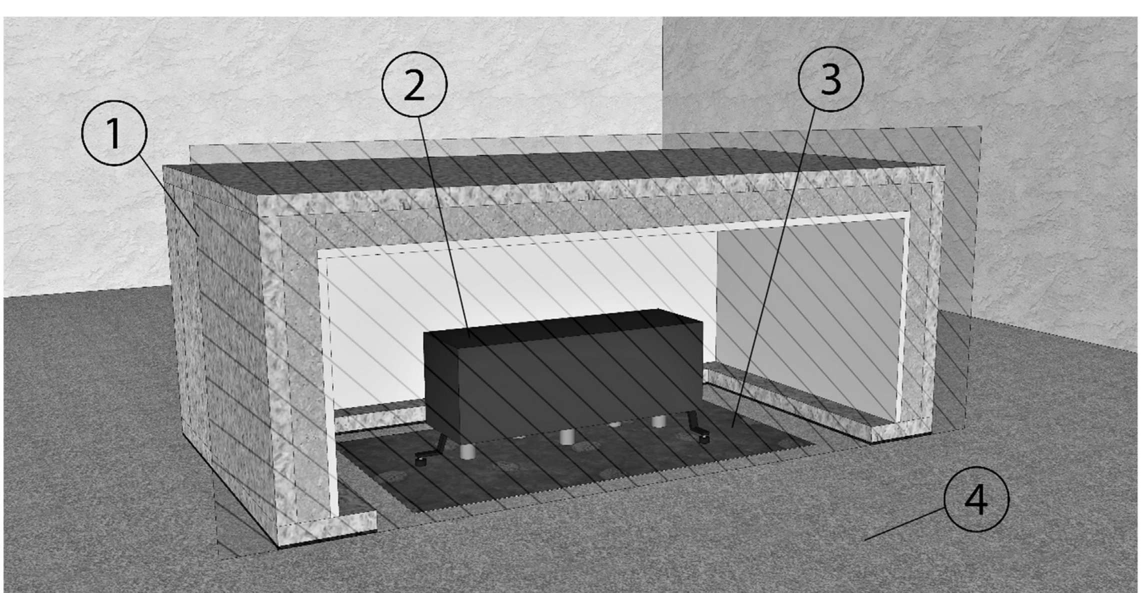

Fig. 1. Cross section through the measurement setup used in the engineering method measurements: mobile insulation case (1), impact sound source – standard tapping machine (2) and tested sample (3), each situated inside a receiving room with a heavyweight floor (4).

Download English Version:

https://daneshyari.com/en/article/8942070

Download Persian Version:

https://daneshyari.com/article/8942070

Daneshyari.com