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A NOTE FROM THE EDITOR-IN-CHIEF

This simultaneous publication of Dr Parmanens's Letter to The Editor and the Comments on it by Drs Jonasson and Simmons which follows it is a departure from the standard *JSV* editorial policy, under which the Comments would have appeared after the Letter's publication, with Dr Parmanen having been offered the right to prepare an Author's Reply for simultaneous publication. All the authors concerned have agreed to the present simultaneous publication. It is appropriate in this case because the matters at issue have arisen in various meetings concerning an ISO standard in which all the authors have been involved.

P. E. Doak

COMMENTS AND CONCLUSIONS BASED ON "ALTERNATIVE REFERENCE CURVES FOR EVALUATION OF THE IMPACT SOUND INSULATION BETWEEN DWELLINGS"

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1. INTRODUCTION

In 1985 Dr K. Bodlund [1] described a survey of sound insulation between modern Swedish dwellings carried out in 1983 by the Swedish National Testing Institute (now the Swedish National Testing and Research Institute) [2]. In his study, published in the *Journal of Sound and Vibration*, Bodlund raised the subject of how to evaluate the impact sound insulation of floors. The study was based on an earler work by Bodlund and Eslon [2] and a study by Bodlund giving additional measurements for Swedish buildings [3]. A total of 138 impact sound insulation measurements were made in the survey, including interviews with occupants to obtain their subjective judgement of impact sound. Occupants' judgements were rated on a scale from 1 (quite unsatisfactory) to 7 (quite satisfactory) based on sounds made by neighbours. In Bodlund's study [1] the 138 measurements were applied as mean values for residential blocks using respective mean subjective scores, as this was judged more meaningful than studying the correlation between the objective measurement result and subjective score for each individual flat. The averaging procedure gave 22 final data points for regression and correlation calculations, including nine from the study by Bodlund [3]. These 22 points were the only ones discussed in Bodlund's survey study [1].

The main finding by Bodlund was that a flat reference curve earlier suggested by Fasold [4] and Olynyk and Northwood [5], or the use of a C-weighting network as in the Japanese standard, were much better alternatives than the ISO method for subjective rating of impact sound. However, an even better choice was found to be a straight curve with a positive slope of 1 dB per 1/3-octave band, starting at 50 Hz and terminating at 1000 Hz. This alternative gave a correlation coefficient as high as 87% when comparing the mean measurement results with mean subjective occupants' scores.

Recently the Technical Committee ISO/TC 43, Subcommittee 2, prepared a new standard for rating of impact sound in buildings and of building elements [6]. In principle

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the new method(s) in ISO/DIS 717 and the old ISO method 717 are very similar. Since there exists evidence that the old method could be improved, a so-called adaptation term was included in the new method in an informative appendix. The new standard 717 also makes it possible to perform the reference curve calculations with octave band measurements. However the respective reference curves for 1/3-octave and for octave band measurements are not similar, i.e. the reference value at 2000 Hz is roughly 4 dB too low compared with other values of the octave band reference curve introduced from the respective 1/3-octave band reference curve. This means that the two curves are not principally consistent, i.e. if applied in a sample of different floors, for example, two different ratings may occur.

The most fundamental idea in the new ISO/DIS 717 method is the so-called spectrum adaptation term, denoted by $C_{I,100-2500}$ or $C_{I,50-2500}$ depending on the frequency range in use. The application of this term means that finally a new rating based on a total normalized impact sound pressure level (obtained by the sum: $L_{n,w} + C_I + 15$) is performed and included in an international standard. Alternatively the adaptation term or terms can be calculated in 1/3-octave bands from 100 to 2500 Hz or in octave bands in the frequency range 125–2000 Hz, and these calculations are in fact equivalent. Additionally the spectrum adaptation term calculations may be carried out for an enlarged frequency range including the 1/3-octave bands 50, 63 and 80 Hz. In principle, the use of two different frequency ranges generates two different ratings. However, the total sound pressure levels over 6 or 5 octave bands give generally only small differences in the final results. Thus the ratings with the above frequency ranges may be almost similar.

The main purpose of the following study is to discuss the results of Bodlund's survey study [1] and explain the principles for constructing a rating method for impact sound generally. The ISO group which performed the new ISO/DIS method 717 used Bodlund's study [1] as their main document when the adaptation term was proposed. One of the other documents referred to was Fasold's study [4]. It seems that in the Nordic Countries at least, the reference curve introduced by Bodlund [1] and associated with his respective new index [1] (denoted by L_B in this study) forms a new independent rating method of superior quality to the other methods proposed. As the following shows, the above methods—i.e. that suggested by Fasold [4], and calculating the total normalized impact sound pressure level in ISO 717 (as done here and denoted by $L_{n,c}$ including the frequency range 50–5000 Hz)—are almost similar generally, particularly in the floor sample used in Bodlund's survey study [1]. However, major differences are found in Bodlund's method [1] compared with the others when applied to the whole sample [2, 3]. These differences are not observable in Bodlund's survey data [1] because of the averaging process used in his study [1].

2. THE SURVEY DATA

The Swedish survey data used by Bodlund [1] consisted of impact sound measurements from his two earlier studies [2, 3]. Because only 22 average values were shown in the survey study [1], all of the data for this study have been taken from the above references. The data taken from the impact sound pressure level curves [2, 3] are shown in Figure 1 in terms of respective values of L_B and $L'_{n,w}$.

According to Bodlund [1] the following relations were obtained by regression calculations:

$$L_B = 86{\cdot}3 - 5{\cdot}53S \qquad [r = 87\%, \qquad n = 22], \tag{1}$$

$$L'_{n,w} = 80{\cdot}6 - 5{\cdot}09S \qquad [r = 75\%, \qquad n = 22]. \tag{2}$$

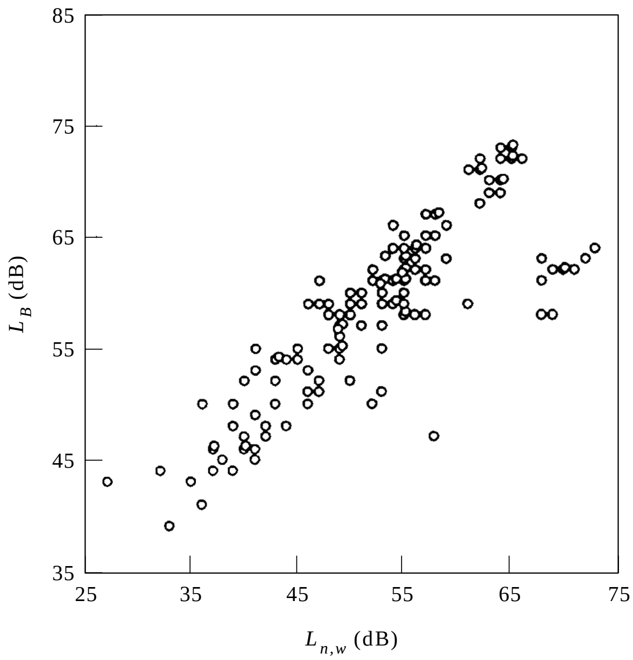

Figure 1. Relation between the weighted normalized impact sound pressure level $L_{n,w}$ and the respective quantity L_B according to Bodlund for the whole material [2, 3].

The equations are presented in their original form, i.e. with the physical objective quantity as a function of the subjective score S. This has naturally no effect on the correlation coefficient r. However, a reversed representation would be preferable, additionally at least, and would show that the dependence of the score on single number quantities is relatively weak (with slopes 0·137 and 0·103 respectively). Then, for example, a unity alteration in the subjective score would need 7 dB alteration in L_B or 10 dB alteration in $L'_{n,w}$.

Bodlund showed statistically that the great difference of correlation coefficients in equation (1) and (2) "is significant from a strict statistical point of view". However, if two cases with hard concrete floors were excluded, the difference between the correlation coefficients would be only 3%. Therefore, some reservations may immediately arise concerning the statistical significance mentioned by Bodlund. Moreover, the data shown in Figure 1 shows that almost all of the measured values of $L'_{n,w}$ are very low. They are mostly clearly below the acceptable maximum weighted sound impact sound pressure levels stipulated by building codes in the Nordic Countries, e.g. $L'_{n,w} \leqslant 58$ dB at present. However, the building codes are under revision and the new requirement will be $L'_{n,w} \leqslant 53$ dB. Therefore, the question arises of how to perform a raiting with values of $L'_{n,w}$ as low as those used by Bodlund [1], i.e. the floors have already been judged subjectively as satisfactory or good in this respect. Additionally, Bodlund [1] did not show the regression line calculations for Fasold's method, although the respective correlation coefficient seems to have been 87%, i.e. the same as for equation (1). Finally, the respective correlation coefficient for C-weighted calculations is also relatively high, i.e. 85%. In Figure 2 the respective relations in Figure 1 for $L'_{n,w}$ and L_B are shown for Fasold's measure (here denoted by L_F). Here, Fasold's measure is performed using twenty-one 1/3-octave bands in the frequency range 50–5000 Hz. The reference curve shape is described later,

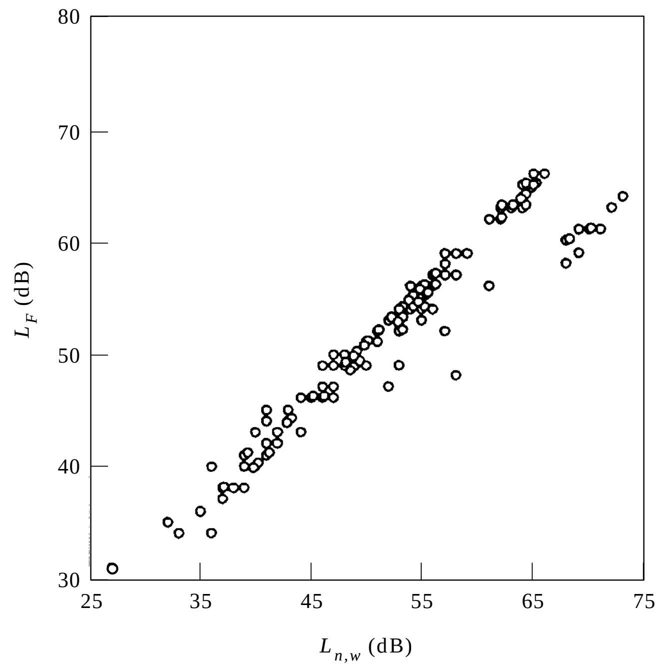

Figure 2. As Figure 1 but relation between $L_{n,w}$ and L_F according to Fasold for the whole material [2, 3],

and because of the number of frequency bands the maximum allowable sum of unfavourable deviations is chosen as 42 dB.

Figures 1 and 2 clearly show that the impact sound pressure level quantity given by Bodlund and the respective quantity by Fasold are principally different impact sound measures according to the weighted normalized impact sound pressure level $L'_{n,w}$. According to the order of performance of different floors generated by $L'_{n,w}$, the order generated by Bodlund's L_B is quite chaotic. In other words, if Bodlund's measure were subjectively sufficient, $L'_{n,w}$ would be wholly insufficient and *vice versa*. On the other hand, if $L'_{n,w}$ were as poor a measure as that shown in Figure 1 for subjective assessment of impact sound, this would undoubtedly have emerged sooner as this type of measure has been in worldwide use of 30–40 years. Therefore, Bodlund's main result concerning the new suggested reference curve [1] cannot generally hold.

Fasold's measure L_F in Figure 2 separates the sample material from Bodlund's earlier studies [2, 3] principally into three categories: In the first and major category, L_F generates the same order of performance as $L'_{n,w}$. In the second category, hard massive floors (with hard floor coverings) generally have a clearly smaller L_F than $L'_{n,w}$. Finally, the third category comprises floors having strong low-frequency components when excited with the standardized tapping machine. In this category Fasold's measure principally generates a different order of performance compared with $L'_{n,w}$ because the frequency bands 50, 63 and 80 Hz are included. This is also seen from Figure 2 by taking into account that in the sample material [2, 3] the greatest low-frequency components were found when $L'_{n,w}$ was very low. From the configurations of Figures 2 and 3 one can see that Fasold's measure L_F operates in almost a similar way to $L_{n,c}$. In fact, the frequency weighting used to perform $L_{n,c}$ is included in Fasold's reference curve method. Therefore, the methods are equivalent in principle. Fasold's method is reviewed below, and is shown to have a stronger base than any of the other methods.

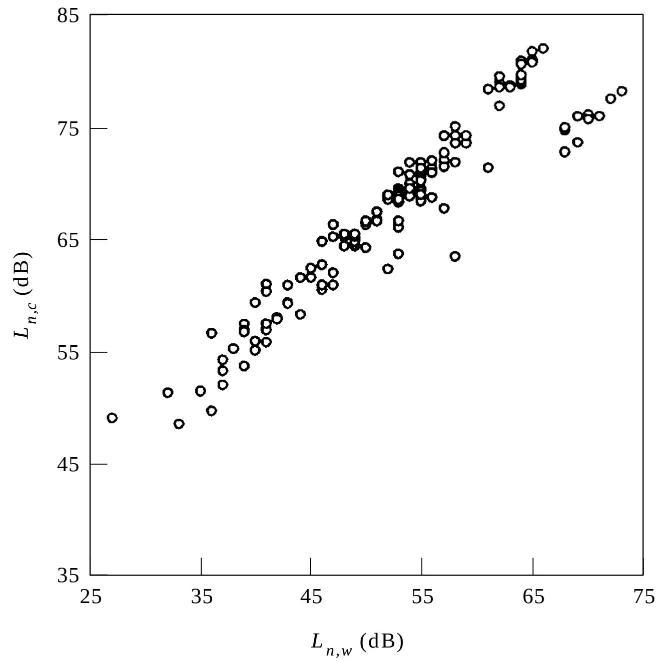

Figure 3. Relation between the weighted normalized impact sound pressure levels $L_{n,w}$ and $L_{n,c}$ in the whole material [2, 3].

3. THE METHOD OF FASOLD

In his 1965 study [4] Fasold considered different kinds of impact sounds and defines a "mean disturbing dwelling noise", and compared usual impact noises with that of a standard impact generator. The "mean disturbing dwelling noise" was defined as a difference in 1/3-octave band levels between living sounds and the impact sounds generated by the standardized tapping machine. These differences in 1/3-octave bands form the basic reference curve in Fasold's study [4], starting from 50 Hz and terminating at 12·5 kHz. Additionally, the shape of the reference curve is affected by the "acceptable noise" in dwellings and by the mean absorption in a receiving room. Thus the final reference curve introduced by Fasold is a horizontal straight line between 1/3-octave bands from 100 to 3150 Hz, with negative slopes of 6 dB/oct below 100 Hz and above 3150 Hz.

Generally, studies concerning impact sound rating lack a definition for the reference curve. The reference curve has not been defined either in the new ISO/DIS 717 method, which is more complex than earlier methods as it includes both direct calculations of weighted sound pressure levels and reference curve algorithms. Moreover, as mentioned above, the reference curve systems in 1/3-octave bands and octave bands lead principally to different ratings. The first attempt to give the reference curve for impact sound rating a meaningful content has been presented by Gösele [7]. Based on Gösele's idea, the reference curve algorithm is equivalent to applying a frequency weighting to the measured normalized sound pressure levels. According to Gösele the frequency weighting terms are included in the reference curve as their negatives. One may thus conclude that generally a reference curve shape for impact sound rating consists of the negatives of the differences characterized by Fasold above, and of the negatives of a weighting for the subjective perceived magnitude of the sound, i.e. of an A-weighting for example. The "acceptable noise" applied by Fasold has a spectrum very near to the reversed

A-weighting. Therefore Fasold's method also quantitatively follows the above conclusion fairly exactly. In summary, the factors above define the reference curve shape unequivocally. This means that for floors one unequivocal rating is obtained, and that altering any of the factors above gives another reference curve and another different rating. In the following, the effect of the receiving room absorption on the reference curve shape is ignored.

One might hope that in an international standard at least, the above differences and especially the weighting for the perceived magnitude of the sound would be defined. On the other hand, the associations between different rating systems should be reviewed and argued in the basic reports. For example, a reference curve method and the calculation of a weighted sound pressure level are quite equivalent as shown by Gösele [7] and more analytically and precisely by the author [8]. Generally, a reference curve method is less sensitive to spectral shape than the respective weighted sound pressure level. One may prefer the use of reference curve methods as these give better reproducibility, as shown by the author [9].

The experiments by Fasold were performed in a laboratory on a bare concrete floor. Fasold mentioned that the differences between living sounds and sounds generated by the tapping machine were transferable from one floor construction to another. However, soft floor coverings were an exception. This is hardly surprising since the total "softness" of the impact would then be dominated by the floor covering alone, and the differences between living sounds and tapping machine sounds would vary strongly depending on the soft floor covering in use. Naturally therefore, Fasold's principle does not hold. Thus the crucial requirement is that the differences in octave or 1/3-octave bands for living sound levels and the sound levels of the standardized impact tapping machine must be defineable and unequivocal; if not, as in the case of different soft floor coverings, no reference curve is defineable. Consequently, it seems that impact sound measurements should generally be done on bare floors. Finally, the need for a living walker claimed by many researchers only seems to exist because of soft coverings, not because of low frequencies caused by, for example, walking. This seems to follow from Fasold's dilemma concerning soft floor coverings, and from these coverings having such properties that only higher frequencies are affected.

4. COMPARISON OF DIFFERENT METHODS

In the following, for the sake of simplicity only the frequency range 100–3150 Hz is considered, and all the methods are compared as though they were defined for this frequency range only. This restriction by no means affects the generality of the considerations below. In order to choose between the different methods above, i.e. mainly the method by Fasold and the reference curve method in ISO 717, some qualitative comparisons may be necessary. Primarily, a soft floor covering is defined. If one assumes that the reductions (improvements) in impact sound pressure level of a hypothetical reference floor covering are like the negatives of the reference curve in ISO 717 (i.e. the improvements in 1/3-octave bands starting at 100 Hz are: 0, 0, 0, 0, 0, 0, 1, 2, 3, 4, 5, 8, 11, 14, 17, 20 dB), and that these reductions are transferable to a bare floor, then by assuming that the same reference curve shifting rules are applied in the same frequency range:

$$L_{F(\text{bare floor})} = L_{n,w(\text{reference covering})} + 2. \tag{3}$$

A generalization of equation (3) gives for floors with floor coverings an almost similar type to the reference covering above, and for bare floors the relation:

$$\text{Rating } (L_F)_{\text{bare floor}} \cong \text{Rating } (L_{n,w})_{\text{floor with soft covering}} + 2, \tag{4}$$

where $\cong$ means "almost equal". "Rating" means a subjective order of floors obtained by the measurements and by a rating method defined for handling the measurement results. Therefore, standardized measurements with a specified tapping machine need not give a subjective order of floors if judged as such in, for example, listening conditions.

If one assumes the method by Fasold to be a perfect method for rating bare floors subjectively, the traditional ISO 717 might only be a special case of such a type of general method for rating bare floors. Namely, as a consequence of equation (3), relation (4) holds exactly for the reference floor covering, the right side then giving the perfect subjective rating for bare floors.

However, the relation will be more erroneous the more the floor covering deviates from the reference floor covering. In practice however, the ISO 717 method has been far more popular than the "perfect general" method. This may be because of its great usefulness for classifying soft floor coverings on hard massive floors, which shows very large improvements caused by floor coverings in weighted impact sound pressure levels. However, in reality these major improvements may be false from a subjective point of view. It should be remembered that the subjectively defined rating in this case concerned bare floors only. In this study, Fasold's method has been regarded as a hypothetical example of a real perfect method. This means that the differences between living sounds and sounds generated by the standardized tapping machine defined by Fasold need not hold in practice, and that to get an even better method these differences should be controlled. For example, today's living impact sounds probably differ from those of Fasold's day.

If it is assumed, in turn, that the reference curve method in ISO 717 is the absolutely perfect way to represent a subjective rating for floors generally, then $L_{n,w}$ is the subjectively representative numerical value for any floor with or without a floor covering. Then impacts by the standardized tapping machine represent living sounds as such, because any further definitions and restrictions are lacking. However, according to the principles put forward by Gösele and Fasold, because differences between living sounds and tapping machine sounds either do not exist or are not defined, the reference curve should represent the weighting for the subjective perceived magnitude of sound only. However, this is not the case as seen from Figure 4, which compares the reference curves of the above methods including the A-weighting as a reference curve application..

Figure 4 shows all the mentioned frequency weightings in a reference curve application. All the curves have the same arithmetic mean of the 1/3 octave band values to show better the differences of the actual frequency weightings. The curve with infinite values above the frequencies at 1000 Hz represents Bodlund's [1] reference curve lacking the values below 100 Hz in this representation.

As Figure 4 shows, the traditional reference curve of ISO 717 and the reversed A-weighting curve are quite different, pointing to the difference between the ISO 717 method and the method used in France (direct calculation of the total overall A-level of the impact sound band pressure levels). The reference curve method of ISO 717 clearly restricts both low and high frequency band sound pressure levels more than does A-weighting. In view of these great differences between the A-weighting and ISO 717 curves, it would seem that the latter method does not include the assumption that the tapping machine represents a living walker or living sounds, as said earlier. Therefore, the working principle characterized above (i.e. ISO 717), if aimed at rating different floor coverings only, might be a good one. The French A-weighting method may not be adequate as it almost totally lacks rating of low frequency sounds. Many researchers have demanded a method for rating low frequency sounds even more severely than ISO 717.

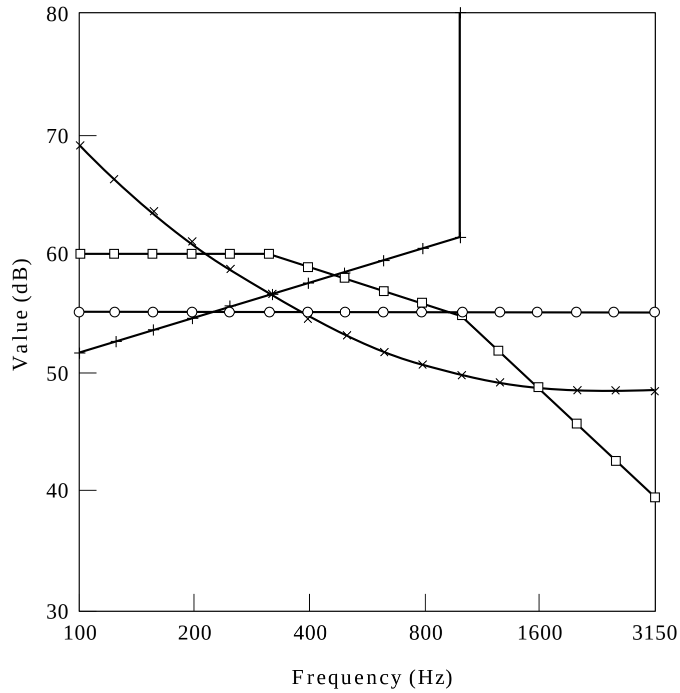

Figure 4. Different reference curves for rating impact sound. □, ISO 717; ○, Fasold [4]; ×, reversed A-weighting; +, Bodlund [1].

The method by Bodlund rates sounds at and below 1000 Hz, totally ignoring sound pressure levels at higher frequencies as these were generally absent in his floor sample [1]. Therefore, the reference curve introduced in his study is not a general one. Finally, the reference curve by Fasold seems to have the smallest discrepancies although the rating of higher frequencies is not a strong feature of his method. Nonetheless, Fasold's method is the only one that is well defined.

5. SHIFTING RULES

In the study by Bodlund [1] several rules for shifting the reference curve were tested. Limit values for the maximum sum of unfavourable deviations were 8, 10, 12, 14, 16, 20, 24, 28, 32, 36, and 40 dB, and the correlation coefficients showed a small variation almost independent of the sum used. Bodlund concluded: "Whether one chooses the standardized value of 32 dB or some other practical value is not an important question". However, this cannot generally hold because a reference curve system is strongly characterized by shifting rules, including the shifting step. Generally a reference curve system approximates an overall sound pressure level with a given frequency weighting. In this respect the accuracy of the approximation is dependent on the shifting rules only. If the sum rule alone is used, a moderate accuracy is achieved with the sum value of 32 dB including sixteen 1/3-octave bands. The accuracy further depends on the shapes of the spectra of the floor sample. With spectra deviating only slightly from the shape of the reference curve, sufficient accuracy is achieved if sum chosen is twice the number of frequency bands in use. The author [8] has introduced the relation between the desired weighted sound pressure level and the single number quantity in a reference curve system as

$$L_{x,w} = L_{d,w} - 10 \log (n) + constant + \sigma, \tag{5}$$

where $L_{x,w}$ represents a single number quantity (reading point) in general ($L_{n,w}$ for example) and $L_{d,w}$ represents the calculated overall sound pressure level with the desired weighting. The equation includes the number of bands in a log-term and a constant besides the dispersion term σ. The constant and the dispersion term depend on the shifting rules and the constant may be adjusted so that the dispersion term has zero mean value within a large general floor sample. If the weighting is chosen to have a value of zero at the reading point, the constant is generally a small negative number. The most important aspect of equation (5) is the manner of including the number of bands. This means that if one changes the reference curve system from 1/3-octave bands to octave bands as in the new ISO/DIS 717, the reading point should be reduced by 10 log (16/5), giving 5 dB as mentioned in ISO/DIS 717. However, the definition and reasonings for this reduction are lacking.

In Bodlund's case, the sum value of 28 dB would be best from a defining point of view. On the other hand, the spectra of the sample used in his study [1] are such that all significant sound pressure levels lie almost below the frequency band of 315 Hz. This means that the reference curve system in this sample operates in practice only with nine bands or even less. It also seems that the sum values of 16 and 20 dB give higher or as high correlation as the limiting value of 32 dB [1]. Therefore, it might have been reasonable to define only the frequency range from 50 to 315 Hz inside of the sample used.

When using Fasold's reference curve for the calculations of Figure 2 in this study, a limiting value of 42 dB for the sum was chosen. In this case, a smaller value would have given L_F values even closer to $L_{n,c}$. In fact, the value could also be smaller, such as 32 dB, because in practice also this method operates with a relatively small number of unfavourable deviations of frequency bands.

If a very high limiting value is used with respect to the number of frequency bands for a reference curve system, a rating of the arithmetic means of the sound pressure levels of the bands is finally obtained, as has been shown in the case of airborne sound insulation [9]. Bodlund [1] used the sum value of 32 dB, the number of bands being nine in practice. Therefore Bodlund's actual result from comparison of reference curves is that the subjective rating is obtained by the arithmetic means of the nine lowest frequency bands. Thus no actual reference curve would have been needed to obtain the main result of Bodlund's study. In fact, only one special property of the reference curve systems was applied to obtain it. Concerning the subjective ratings with arithmetical means of sound pressure band levels see, for example, the study by Tachibana *et al*. [10], and the conclusions by the author [11].

If a very small limit for the sum value of a reference curve system is applied, the rating finally occurs with the frequency band having the greatest unfavourable deviation. On the other hand, a reference curve system may be amended with such a special limiting rule for the maximum unfavourable deviation, and the maximum deviation rule calculations by Bodlund [1] were carried out with rules for 1–8 dB. In the floor sample used by Bodlund, the unfavourable deviations with the reference curve used occured mostly under the 315 Hz frequency band, and the correlation coefficient seems to increase when the maximum allowed unfavourable deviation is reduced. For example, the reference curve method amended with the 1 dB rule gave the highest correlation coefficient, i.e. 87·3% in a similar equation to equation (1). This should have shown that the subjective rating is only strongly dependent on the high standardized sound pressure levels in the low frequency range of the floor sample considered. However, this was not mentioned by Bodlund. Nor was the reference curve method amended with the 1-dB rule suggested as an alternative method.

This should have been done on the basis of the ''general characteristics'' of the floor sample, because of no word was mentioned of possible restrictions in the data sample. At any rate, no general reference curve method was needed to demonstrate the above properties of the floor sample in Bodlund's study [1].

6. DISCUSSION

It has been shown based on the floor sample used by Bodlund [1] that the reference curve introduced in his study [1] is a misleading one. In other words, the suggested reference curve method functions only in a particular sample chosen by the authors of Swedish surveys. From a definition point of view, the suggested method [1] does not fullfil the general requirements of a reference curve method. It also seems that all the ideas, i.e. the basic principles by Fasold and Gösele to construct a reference curve and shifting rules, were unknown when performing the study. Experiments with differing sum and maximum deviation rules associated with the suggested reference curve show that the author of the study lost control of the final result. As shown above, the actual result was that the whole sample of different measurements included significant sound pressure levels on the lowest frequencies only, and therefore all the rating methods demonstrating this were virtually similar. Among other international researchers the study is misleading and uncontrollable, as there is no reasonable knowledge of the floor sample used. For example, the $L'_{n,w}$ s for the whole sample could have been shown. Moreover, in view of the size of the sample, i.e. 138 measurements, it would not have been hard to show all the data in 1/3-octave bands.

In the comments concerning Bodlund's study [1] the method by Fasold [4] has been considered. This method seems well-based and could be developed as a main international method for gaining a subjective order for floors against impact sound. This method could reasonably operate within a frequency range of 100–3150 Hz, the reference curve being a horizontal straight line. On the other hand, it may be necessary to check the curve shape by studying living sounds with a similar method applied by Fasold, and to increase the frequency range if needed. One should also remember that this rating method is quite similar to that in ISO/DIS 717, i.e. it is based on the overall normalized impact sound pressure level calculated in the frequency range 50 or 100–2500 Hz. In particular, this method should be based on a reference curve procedure because of reproducibility problems caused by low frequency measurements and the emphasis of the method on these.

Finally, the new method ISO/DIS 717 has also come under discussion. The Technical Committee ISO/TC 43, Subcommittee 2, prepared a new standard method for rating impact sound, i.e. method ISO/DIS 717. This method was criticized because of its complexity and because it includes both equivalent and different methods. For example, both the reference curve methods are, or should be, similar, and both methods for calculating the overall sound pressure level within the same frequency range are trivially similar. Despite this, no reasoning for this is put forward in the standard. The result is numerous similar or different single number quantities for rating a floor. This is a serious problem because of the difficulties in choosing the correct quantity in, e.g. national building codes. Besides the principal difference between the two reference curve methods, the draft standard includes oversights concerning especially the annexes. For example, Annex B introduces the so-called reference floor covering. According to $L_{n,w}$ the applications of the reference floor covering have been taken directly from the DIN standard [12] but this is not given as a reference. Moreover, the reference floor covering applications are extended to cover spectrum adaptation terms, and in this respect the definitions of the desired quantities are sloppy: for example, in Annex A the weighted reduction term ΔL_{lin} has not been defined directly, and several equations are therefore needed to define $C_{I,\Delta}$ i.e. a defined difference of the defined basic quantities ΔL_w and ΔL_{lin}. Earlier, the great number of different single number quantities was criticized by the author in the case of airborne sound insulation [9]. It was concluded that if the respective Swedish origin proposal were to be accepted, this would cause chaos in international sound insulation ratings. On the basis of several basic discrepancies found in ISO/DIS 717-2.2 [6] this chaos also seems to concern impact sound.

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